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RESEARCH PROJECT

STATE: Montana

PROJECT NO.: W-120-R-16 & 17

STUDY NO.: BG-2.0

JOB NO.: 3

(Supplement)

TITLE: Statewide Wildlife Research

TITLE: Statewide White-tailed Deer Ecology Studies

TITLE: Population ecology and habitat relationships of white-tailed deer in river bottom habitat in eastern Montana
(Distribution of white-tailed deer along the lower Yellowstone River)

Period Covered: July 1, 1984 - September 1986


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Bradley Byford Compton was born in Hayward, California on February 17, 1961 to William and Eula Compton. He attended high school in Kalispell, MT. After graduating in 1979, he enrolled at Montana State University. In the spring of 1984 he received a Bachelor of Science degree in Fish and Wildlife Management. In July of the same year he began his graduate program leading to a Master of Science degree in Fish and Wildlife Management.



ACKNOWLEDGMENTS

I would like to express my utmost gratitude to Dr. R. J. Mackie for his guidance, support, and overall assistance to this project. Special thanks also go to Gary Dusek for his field assistance and helpful suggestions, Dr. R. L. Eng, Dr. H. D. Picton, Dr. K. M. Havstad, and Dr. R. J. White for their review of this manuscript. I am also grateful to the following for their individual efforts: J. D. Herriges, A. K. Wood, and C. Bittinger for their assistance with computer packages; R. Boik for statistical advice; and K. Kinden for providing flight service. Sincere thanks go to the landowners of the study area for without their cooperation this project would not have been possible. Brent and others of the Hagler families deserve special thanks for their hospitality and friendship. Finally, I would like to thank my family and friends who supported me throughout this project. This project was financially supported by the Montana Department of Fish, Wildlife, and Parks Federal Aid Project W-120-R.

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ABSTRACT

A study was conducted to evaluate factors influencing distribution of white-tailed deer (Odocoileus virginianus) along the lower Yellowstone River in eastern Montana during summer 1984, and winter-summer-fall 1985. Relationships between riparian vegetation, cattle grazing, and other land use practices and distribution and habitat use of deer were determined using radio telemetry, spotlighting, and aerial distribution surveys. The influence of cattle grazing on native vegetation within mature cottonwood, green ash, and shrub cover types was evaluated using percentage canopy coverage estimates and vegetational profiles. The amount of riparian cover (forest + shrub) was the most important factor influencing deer distribution along the study area. Deer preferred cover types dominated by woody riparian vegetation during the day and agricultural fields during the night. Alfalfa was the primary crop used in summer. Deer shifted from alfalfa to grain and sugar beet fields during fall. Deer used fields with residual crop material available during winter. Distribution and availability of crop types, season, and cropping practices were factors influencing use and selection of agricultural types. Deer avoided ($P < .05$) areas with cattle. Cattle grazing generally decreased shrub cover and increased grass cover within sampled types. During hunting seasons deer increased movements and used islands and uplands more than other seasons.

INTRODUCTION

Riparian areas provide the primary habitat for white-tailed deer in eastern Montana (Allen 1968, Swenson et al. 1983, and Herriges 1986). Many riparian habitats, especially bottomlands associated with large rivers are privately owned and used for production of agricultural crops and livestock. Only limited data are available on relationships between land use and management practices and white-tailed deer ecology and distribution in those habitats.

In 1980, the Montana Department of Fish, Wildlife, and Parks initiated studies to evaluate population ecology and habitat relationships of white-tailed deer along the intensively farmed lower Yellowstone River. These included detailed investigations of population characteristics and dynamics (Dusek 1985) and habitat use relationships (Herriges 1986).

My study was initiated in July 1984 to provide additional data on habitat relationships. Specific objectives were: 1) to determine distribution and habitat use of white-tailed deer in relation to riparian vegetation and land uses along the lower Yellowstone River, and 2) to evaluate possible specific influences of livestock grazing

and other land use practices on distribution, habitat use, and abundance of deer in river bottom habitat. Field studies were conducted primarily during July-September 1984, January-March 1985, and July-December 1985.

DESCRIPTION OF STUDY AREA

The study area, encompassing 118.9 km² of floodplain and islands, extended approximately 50 km along the Yellowstone River between Glendive and the Elk Island Wildlife Management and Recreation Area (EIWMA) near Savage (Fig. 1). Three intensive study units, selected as representative of major land uses within the total area, were located near Glendive, at the mouth of Burns Creek, and in the vicinity of the EIWMA.

Physical and/or biotic characteristics of the river valley within the total study area have been described in various detail by Holder and Pescador (1976), Swenson (1978), Pescador and Brockman (1980), Dusek (1981), Bozgs (1984), and Herriges (1986). In summary, the Yellowstone River flows north-easterly through a 1-5 km wide alluvial floodplain at elevations ranging from 625 m at Glendive to 574 m on the EIWMA. The floodplain is bounded by terraces, steep "breaks", and rolling uplands interspersed by numerous draws and several tributary drainages emptying into the river from the northwest and southeast. Soils of the floodplain are deep fine sandy loams and silt loams underlain by stratified fine sand loam to silty clay alluvium (Holder and Pescador 1976).

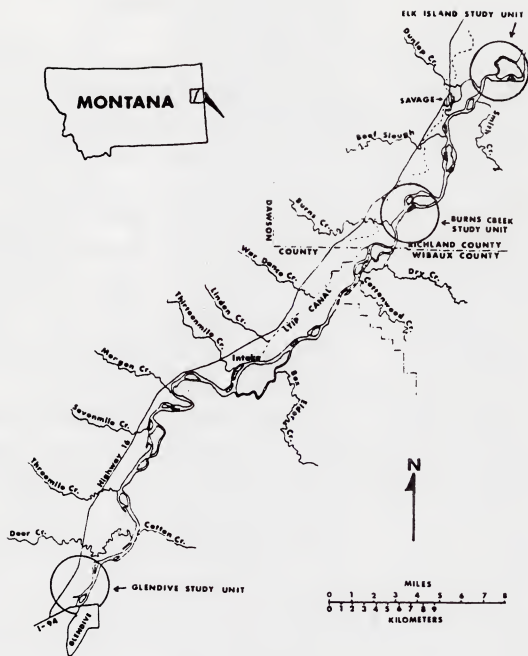


Figure 1. The lower Yellowstone River study area.

The climate is continental, characterized by sunny warm summers and cold winters with moderate snowfall (Pescador and Brockman 1980). Average monthly temperatures range from -11 C in January to 22 C in July. Precipitation averages 30-36 cm annually, 80% of which falls during April-September. Winter snowfall averages 71-81 cm. During the study, the summer of 1984 was dry and the winter of 1984/1985 near normal in temperature and precipitation, while the summer/fall of 1985 was below average for temperature and above average for precipitation (Fig. 2).

Vegetation cover types along the floodplain have been described by Boggs (1984) and Herriges (1986). Those of concern in this study included: gravelbar, willow-cottonwood thicket, young cottonwood, mature cottonwood, shrub, grassland (floodplain), mature willow, green ash, slough, and agricultural fields. Plant species names follow Booth and Wright (1966) and Booth (1972). Common names follow Scott and Wasser (1980).

Plant cover on the gravelbar type (sandbar type of Herriges, 1986) varied from none, to a few forbs and grasses, to seedlings of eastern cottonwood (Populus deltoides) and willow (Salix spp.).

The willow-cottonwood thicket type consisted of dense stands of cottonwood and willow saplings. The understory was sparse, consisting primarily of grasses.

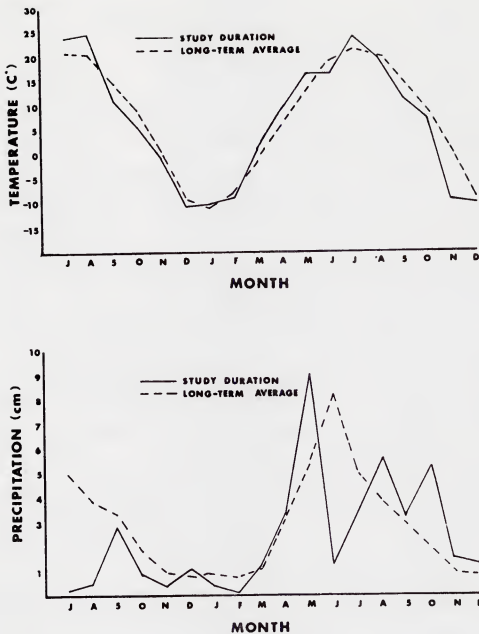


Figure 2. Mean monthly temperature and precipitation at Savage MT during the study period, July 1984 to December 1985, compared with the long term average. Data for November 1985 from Glendive.

The young cottonwood type was characterized by a dense canopy of young cottonwood trees with a grass understory. Primary grasses were Canada wildrye (Elymus canadensis) and marsh muhly (Muhlenbergia racemosa).

The mature cottonwood type, typified by a reduction in tree density and canopy from the young cottonwood type, was usually accompanied by a shrub understory. Primary shrubs included western snowberry (Symphoricarpos occidentalis) and Woods rose (Rosa woodsii).

The shrub type was dominated by Woods rose and western snowberry. Some decadent cottonwoods persisted and dead-standing shrubs were common.

The grassland type was dominated by grasses with interspersed decadent cottonwoods and patches of silver sagebrush (Artemisia cana). Common grasses included: western wheatgrass (Agropyron smithii), prairie sandreed (Calamovilfa longifolia), Canada wildrye, marsh muhly, quack grass (Agropyron repens), needle-and-thread (Stipa comata), smooth brome (Bromus inermis), and crested wheatgrass (Agropyron cristatum).

The green ash (Fraxinus pennsylvanica) type was characterized by a dense overstory with an understory ranging from shrubs to grasses. Primary shrubs were western snowberry and Woods rose. Common grasses included smooth brome, marsh muhly, Canada wildrye, and bluegrass (Poa spp.).

The mature willow type was dominated by dense stands of peachleaf willow (Salix amygdaloides). The understory generally consisted of smooth brome.

The slough type typically occurred along old river channels. Cat-tail (Typha spp.), common reed (Phragmites communis), and horsetail (Equisetum spp.) dominated.

The agricultural field type consisted of grain, corn, sugar beet, pinto bean, alfalfa, or sorghum fields, and grass hay meadows. Alfalfa was grown for hay, corn primarily for silage, and others as cash crops. The grass hay meadow type consisted of floodplain grassland often interseeded with smooth brome and some crested wheatgrass.

Successional relationships for natural riparian communities within the study area (Bozgs 1984) are as follows: as gravel bars are formed by river dynamics, willow and eastern cottonwood seedlings may become established. A cottonwood seral stage follows. Under this canopy a shrub layer establishes with western snowberry and Woods rose dominating. The mature cottonwood stage is replaced by the shrub sere, which in turn is followed by a climax grassland stage. Green ash may also become climax following either a peachleaf willow and seedling willow stage developed from some gravel/sandbars or locally on other sites, following willow-cottonwood thickets or mature cottonwood stages.

Land uses along the study area, as determined by responses from a questionnaire delivered to 43 landowners (Appendix B, Fig. 12), are summarized in Table 1. Livestock, primarily cattle, and irrigated alfalfa/hay were most important economically, followed by irrigated cash crops (sugar beets, corn, grain, and pinto beans), dryland cash crops, and dryland alfalfa/hay. Land use varied with ownership, floodplain width, and the Lower Yellowstone Irrigation Project, LYIP, (Herriges 1986) which diverts water from the river through canals to bottomlands below the diversion dam located at Intake, approximately 25 km north of Glendive (Fig. 1).

Table 1. Occurrence and relative importance of various land uses on the lower Yellowstone River study area as reported by 43 landowners. Proportions in parenthesis.

LAND USE PRACTICE	NUMBER OF LANDOWNERS	NUMBER OF LANDOWNERS AND REPORTED LEVEL OF IMPORTANCE				
		1 ^a	2	3	4	5
LIVESTOCK	35 (.81)	13(.37)	16(.46)	6(.17)	-	-
IR ^b ALFALFA/HAY	35 (.81)	13(.37)	13(.37)	9(.26)	-	-
IR CASH CROPS	22 (.51)	9(.41)	9(.41)	3(.14)	-	1(.05)
DR ^c CASH CROPS	12 (.28)	6(.50)	1(.08)	2(.17)	2(.17)	1(.08)
DR ALFALFA/HAY	11 (.26)	2(.18)	1(.09)	4(.36)	3(.27)	1(.09)

^a 1=highest level of importance, 5=lowest

^b IR=irrigated

^c DR=dryland

The Elk Island study unit (Fig. 3), which comprised 16 km² and included the EIWMA, has been described by Dusek (1981) and Herriges (1986). Agricultural cropping of alfalfa, grain, sugar beets, pinto beans, and corn, and livestock was the fundamental land use. This unit was composed of 28 ha gravelbar, 37 ha willow-cottonwood thicket, 85 ha young cottonwood, 212 ha mature cottonwood, 110 ha shrub, 43 ha mature willow, 17 ha green ash, 27 ha slough and 595 ha of agricultural lands (Herriges 1986).

The Burns Creek study unit (Fig. 4), 13.6 km², lies approximately 9.5 km upstream from the Elk Island unit. The primary land uses were livestock production and cultivation of sugar beets, corn, grain, alfalfa, and sorghum. Grass hay meadows also occurred. This unit consisted of 45 ha gravelbar, 53 ha willow-cottonwood thicket, 58 ha young cottonwood, 235 ha mature cottonwood, 58 ha shrub, 102 ha grassland, 47 ha mature willow, 42 ha green ash, 15 ha slough, and 393 ha of agricultural lands.

The Glendive study unit (Fig. 5), encompassed 7.4 km² at the southern boundary of the study area. Livestock, alfalfa, grain, and grass hay meadow production were the primary land uses. This unit was composed of 45 ha gravelbar, 82 ha willow-cottonwood thicket, 33 ha young cottonwood, 42 ha mature cottonwood, 43 ha shrub, 45 ha upland grassland, 63 ha floodplain grassland, 12 ha mature willow, 14 ha green ash, 6 ha slough, and 214 ha crop lands.

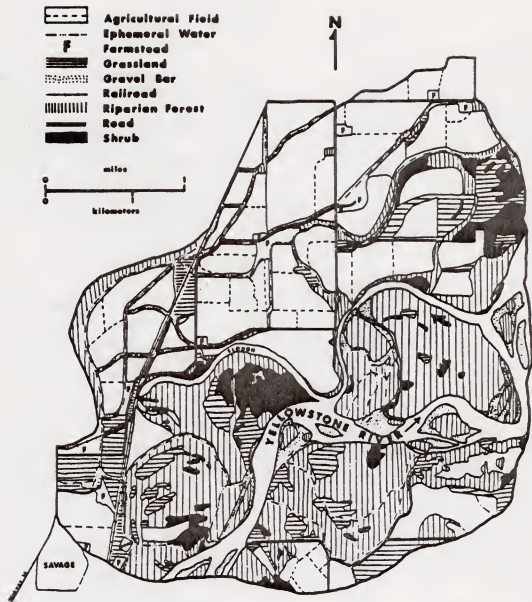


Figure 3. Elk Island study unit.

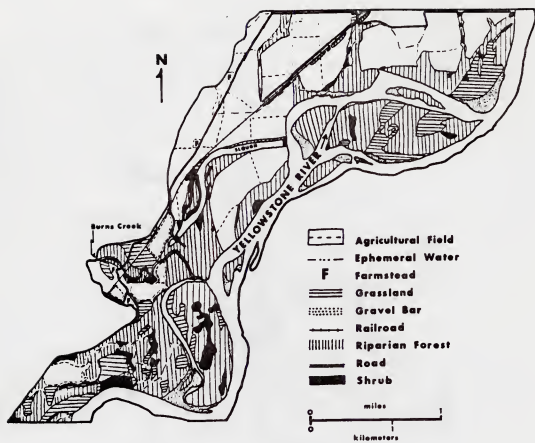


Figure 4. Burns Creek study unit.

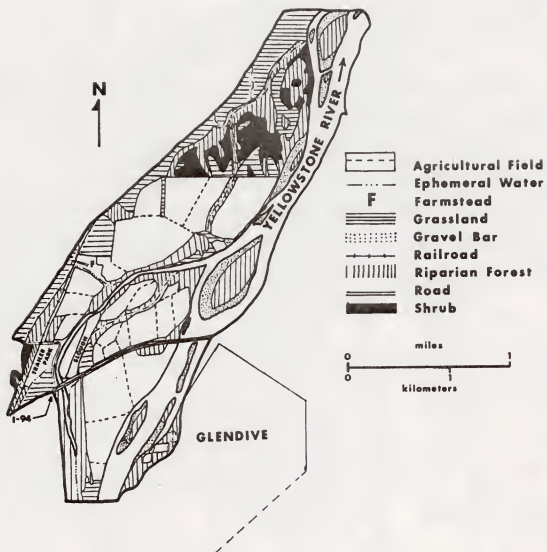


Figure 5. Glendive study unit.

The harvesting of crops on the study area begins with grain in August, followed by corn during September and sugar beets and pinto beans in October. Alfalfa is harvested for hay from 2-3 times annually; the first cutting usually occurs in June, the second cutting in July, and a final cutting in September.

Hunting along the river bottom occurred between September 7 and December 8, 1985. Various seasons included: archery (September 7-October 12); antlerless deer (October 13-December 1); general deer (October 27-December 1); and pheasant (October 19-December 8).

METHODS

Field Methods

Deer Distribution Surveys

Five aerial surveys covering the entire study area were conducted during 1985, using a Piper SuperCub, to determine deer distribution. Surveys included 2 in winter (February 13 and March 18), 1 in summer (August 28), and 2 in fall (October 8 and December 3). Flights were made during morning and evening when deer were most active (Herriges 1986). Number and location of deer and the habitat type occupied were recorded; cattle distribution was also noted.

Deer Capture and Marking

Deer were captured on the Burns Creek and Glendive study units using clover traps (Clover 1954) and cannon nets (Hawkins et al. 1968) from January through March 1985. Corn and green alfalfa were used as bait. Deer were fitted with either individually recognizable neck bands or radio collars. A total of 39 deer were captured; 26 at Burns Creek (9 radio-collared) and 13 at Glendive (8 radio-collared). The Elk Island study unit was solely used for spotlight surveys, thus precluding the need for monitoring marked deer.

Relocation

Deer were relocated primarily through radio telemetry. Aerial relocations were obtained from a Piper SuperCub at approximately 2 week intervals. Relocations were also obtained through triangulation (Heezen and Tester 1967) using a 2 element antenna mounted on a vehicle. During fall 1986, 5 triangulation sessions, spanning 8-hour periods, were conducted at the Burns Creek study unit using 2 truck-mounted precision direction finding antenna arrays (Telonics Inc., Mesa, Arizona) as described by Herriges (1986). Accuracy of triangulation based on control beacons at known locations was approximately 100 meters. Radio-collared deer were also located by direct observation during aerial flights, walk ins, spotlight surveys, and general reconnaissance of the study areas as described by Herriges (1986). These techniques provided a total of 558 relocations of radio-collared deer, including 416 at Burns Creek and 142 at Glendive. Each relocation was assigned a coordinate to the nearest 100 meter interval based on a Universal Transverse Mercator (UTM) grid. Time, date, and habitat type were also assigned to each location.

Spotlight Surveys

Spotlight surveys were conducted at all 3 study units to determine trends in use of and selection for agricultural crop types. Surveys were conducted weekly while traveling established routes using a 200,000 or

300,000 candlepower hand-held spotlight as described by Compton (1986). Counts began at least one hour after uniform darkness and lasted 1-2 hours, the time when deer activity is highest (Montgomery 1963, Progulski and Duerre 1964, Herriges 1986). Data recorded included the number of deer observed in each field, date, temperature, relative wind velocity, and other general weather conditions.

Vegetation Analysis

Vegetation characteristics were analyzed within 3 cover types (mature cottonwood, shrub, and green ash), under 3 different grazing intensities (light, moderate, and heavy), and in relation to 2 different grazing seasons (summer or winter). Percent canopy coverage (Daubenmire 1959) by species was estimated within 4 x 10 decimeter quadrat frames placed at 5 meter intervals along 3 parallel 50-meter transects in each type sampled. A spherical densiometer (Lemmon 1956) was used to estimate overhead canopy. Vegetation profile (Nudds 1977) was evaluated by using a vegetational profile board placed at 10 meter intervals along each transect with a cover density score recorded at distances of 10, 15, and 20 meters. Only results recorded at 15 m are reported because variation was greatest at this distance.

Vegetation Cover Mapping

Vegetation cover-type maps for the entire study area were prepared using aerial photographs and ground truthing. Types delineated were: gravel bar, riparian forest, shrub, grassland, and agriculture. Riparian forest type included the willow-cottonwood thickets, cottonwood, mature willow, and green ash community types.

Analytical Methods

Distribution

Distribution of deer along the study area was analyzed by multiple regression. The river bottom was divided into 28 sections, approximately 1.6 km in length, using geographical features as boundaries when possible. The number of deer observed in each section for each survey flight was the dependent variable. Within each section various habitat attributes were measured, using a compensating polar planimeter or dot grid, as independent variables. Variables included the total area in each section, amount of riparian forest, amount of shrub cover, amount of riparian cover (riparian forest and shrub cover), amount of island area, total amount of grazed area, amount of riparian cover grazed, amount of ungrazed riparian cover, total amount of agriculture, amount of grain, amount of alfalfa, and amount of row crops (corn,

sugar beets, and pinto beans). Various combinations of 6 or fewer of the variables were tested individually to determine the best fit.

Overall densities of deer along the entire study area were estimated for each survey flight by dividing the number of deer actually observed in each section by their relative observability. Observability was calculated by dividing the total number of deer observed during each flight by the estimated total number present calculated previously as a Lincoln Index (Dusek unpubl. data).

Habitat and Agricultural Use

Diurnal and nocturnal habitat use was based on radio-collared deer relocations. Selection of agricultural crop types was based on spotlight counts. Radio-collared deer exhibited the same trends in crop type selection as deer observed in spotlight counts. Habitat use and selection of crop types was evaluated following methods described by Neu et al. (1974).

Home Range

Indicators of home range size, minimum convex polygon and average activity radius (AAR) (Hayne 1949) were calculated by season using the TELDAY computer program (Lonner and Burkhalter 1986). Only aerial and other visually confirmed relocations were used. Number of relocation points used by season ranged from 5 to 11 per

animal. Dusek and Wood (1986) recommended that similar numbers of relocations should be employed in analysis of seasonal differences and trends in AAR. Both daytime and total (24 hour) home ranges and AAR's were calculated. Because of the inherent sensitivity of the convex polygon home range size to the number of relocations used (Mares et al. 1980), only AAR's were used in statistical analyses. One-way analysis of variance was used to determine differences in AAR's between age, season, and study unit.

Vegetation Analysis

Differences in percent canopy coverage, vegetational profiles, and overhead canopy within and between cover types and grazing treatments were evaluated using one-way analysis of variance.

RESULTS

Density Distribution Of White-tailed Deer

White-tailed deer were distributed continuously along the entire length of the study area, but relative densities varied (Fig. 6). Medium-high (25-50 deer/km²) to high (>50 deer/km²) densities occurred on 2 sections of river bottom; 1 located south of Intake, the other near Savage. Low densities (<15 deer/km²) were indicated for bottomlands near the mouth of Deer Creek (Fig. 6) and the portion of river bottom between Intake and the Burns Creek study unit. Densities on the Burns Creek study unit ranged from low to medium-high, while densities on the Glendive unit were medium-low (15-25 deer/km²) to medium-high. Sections of the river bottom having low to medium-low densities were typically areas with low river sinuosity and small amounts of riparian cover. Sections with medium-high to high densities had greater river sinuosity and large tracts of riparian cover.

Analysis of density distribution in relation to habitat/environmental factors among individual sections of river bottom indicated that riparian cover was the single most important factor affecting deer density/distribution along the study area. Eighty-three percent of the 1,570

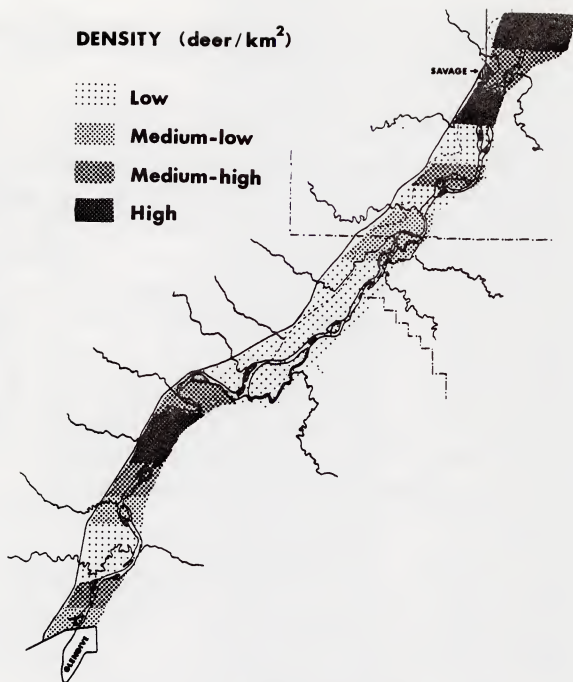


Figure 6. Distribution/density of white-tailed deer along the lower Yellowstone River study area, based on the average of 5 survey flight estimates during 1985.

deer observed during the 5 survey flights were located in riparian cover. There was a significant ($P < .0001$) direct relationship between the amount of riparian cover (ha) and the average estimated number of deer per section of river bottom for all seasonal surveys combined (Fig. 7), as well as between amount of riparian cover and the number of deer observed in each section for each of the 5 individual surveys (Table 2). The amount of riparian cover alone explained 70% of the overall variation in deer numbers among sections of river bottom.

The multiple regression models relating deer numbers observed during individual survey flights to habitat/environmental variables (Table 2) indicated that amount of riparian cover (ha) in which cattle occurred and the amount of island area (ha) also influenced deer density distribution. These variables, together with total riparian cover, collectively explained 56% to 77% of the variability in deer numbers observed among sections of river bottom during surveys. When other variables were included (see methods), they did not significantly ($P > .05$) improve the fit of the models.

The presence of cattle was the second most important factor influencing density distribution of deer along the river bottom. For all surveys, deer were observed significantly ($P < .05$) more often in areas where cattle did not occur. Cattle occurred on 57% (2,129 ha) of the

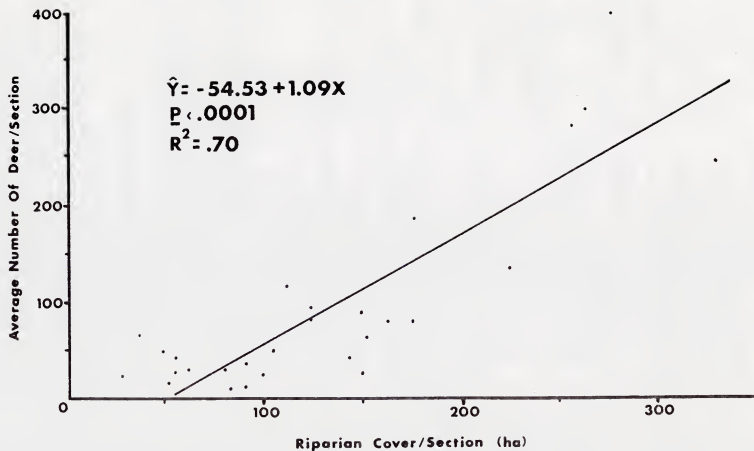


Figure 7. Relationship between the amount of riparian cover (forest + shrub) and the average estimated number of deer per section, based on 5 distributional survey flights.

Table 2. Multiple regression models, based on the number of deer observed (dependent variable) in each section of river bottom, for the 5 distribution survey flights along the lower Yellowstone River study area, 1985.

Survey Flight	Model	P-value	R ²	X1	X2
Mid-winter	$Y = -3.69 + .92X_1 - .50X_2$	<.0001	.57	RC	GRC
Late winter	$Y = -5.86 + .75X_1$	<.0001	.56	RC	-
Summer	$Y = -5.25 + 1.02X_1 - .31X_2$	<.0001	.74	RC	GRC
Early fall	$Y = -20.83 + .52X_1 + .53X_2$	<.0001	.77	RC	IA
Late fall	$Y = -2.52 + .56X_1 + .38X_2$	<.0001	.63	RC	IA

RC amount of riparian cover (ha)
 GRC amount of riparian cover with cattle (ha)
 IA amount of island area (ha)

riparian cover in the study area during the midwinter (February 13) survey, while 63% of the 252 deer observed in riparian cover were in areas without cattle. In late winter (March 18), cattle occurred on 3% (126 ha) of the riparian cover. All 363 deer observed in riparian cover were located in areas without cattle.

In summer, cattle were present on 40% (1,500 ha) of the riparian cover. Of 168 observations of deer in riparian cover, 135 (80%) occurred in areas void of cattle.

During early (October 8) and late (December 3) fall distribution surveys, cattle occurred on 36% (1,346 ha) and 21% (770 ha), respectively, of the riparian cover available. These areas provided only 39 (18%) and 30 (11%) deer observations during October and December, respectively.

The amount of island area was directly related to the number of deer observed during the 2 fall survey flights. This was assumed to reflect increased use of islands by deer during this period.

Distribution and Habitat Use Among Study Units

Monitoring of radio-collared deer and spotlight surveys on individual study units substantiated the importance of riparian cover and cattle in determining deer distribution and habitat use. In addition, they indicated that the kind and distribution of agricultural practices and hunting during the fall were also important factors influencing local distribution and patterns of habitat use.

During daytime, radioed deer on both the Burns Creek and Glendive study units were located in tracts of riparian cover of various sizes. Within riparian cover, they significantly ($P < .05$) selected areas where cattle were absent. Only 11 (5%) of 240 total daytime relocations over all seasons were in areas where cattle occurred, thus, areas included in habitat selection analysis were corrected to exclude those areas where cattle were present.

Habitat Selection

Whitetails generally exhibited similar habitat selection among seasons on the Burns Creek and Glendive study units (Tables 3, 4, and 5). During the day, radioed deer preferred willow-cottonwood thicket (willow thicket),

Table 3. Habitat selection by radio-collared deer at Burns Creek (BC) and Glendive (G) study units for diurnal and nocturnal periods during winter, summer, and fall combined.

Habitat Type	DIURNAL		NOCTURNAL	
	BC(165)	G(85)	BC(204)	G(46)
Gravel Bar	-**	-**	-*	-*
Willow Thicket	+	+	0	-**
Yng. Cottonwood	+	0	0	0
Mat. Cottonwood	+	+	0	0
Shrub	+	+	0	-
Fld. Grassland	-**	-**	0	0
Mat. Willow	+	+	0	0
Green Ash	0	+	-*	0
Slough	-**	0	-*	0
Agriculture	-**	-**	+	+

* significant at $P=.10$

** significant at $P=.05$

() number of habitat type points

+ utilization greater than availability

0 utilization equals availability

- utilization less than availability

Table 4. Habitat selection by radio-collared deer at Burns Creek study unit during diurnal and nocturnal periods for winter (W), summer (S), and fall (F), 1985.

HABITAT TYPE	DIURNAL			NOCTURNAL		
	W(40)	S(37)	F(95)	W(19)	S(32)	F(153)
Gravel Bar	-	-	-**	-	-	-**
Willow Thicket	-	-	+**	-	0	0
Yng. Cottonwood	-	+**	+**	-	-	-**
Mat. Cottonwood	+	+	+	-**	-**	-
Shrub	+	+	+	0	-	-
Grassland	-	-**	-*	-	-*	-
Mat. Willow	+	+	+	-	0	0
Green Ash	0	+	+	-	-	-
Agriculture	-**	-**	-**	+**	+**	+**

* significant at $\bar{P}=.10$

** significant at $\bar{P}=.05$

() number of habitat type points

+ utilization greater than availability

0 utilization equals availability

- utilization less than availability

Table 5. Habitat selection by radio-collared deer at Glendive study unit during diurnal and nocturnal periods for winter (W), summer (S), and fall (F) 1985.

Habitat Type	DIURNAL			NOCTURNAL		
	W(13)	S(19)	F(53)	W(16)	S(10)	F(20)
Gravel Bar	-*	-	-*	-	-	-
Willow Thicket	+	-	++	-	-	-
Yng. Cottonwood	-	+	0	-	-	+
Mat. Cottonwood	NA	+	+	NA	-	+
Shrub	++	+	+	-	-	+
Fld. Grassland	NA	-	-**	NA	-	0
Mat. Willow	+	+	+	-	+	-
Green Ash	0	+	+	+	-	-
Slough	NA	+	0	NA	-	-
Agriculture	-**	-**	-**	+	++	+

* significant at $P=.10$

** significant at $P=.05$

() number of habitat type points

+

0 utilization equals availability

- utilization less than availability

NA not available

young cottonwood, mature cottonwood, green ash, mature willow, and shrub cover types. Use of gravel bars, grasslands, sloughs, and agricultural fields was proportionately equal to or less than availability. Nighttime relocations of radio-collared deer indicated a preference for agricultural fields during all seasons. Use of other types was either less than or equal to availability.

Overall habitat preferences based on aerial surveys differed somewhat from radio-collared deer and varied more between units (Tables 6 and 7). Aerial surveys indicated greater use and preference for willow-cottonwood thickets and less for green ash and mature willow types. These and other differences probably reflected differences in relative observability of deer in the various types from the air. Both aerial surveys and telemetry indicated an avoidance of agriculture during the day.

During all seasons, radio-collared deer on both study units consistently selected for the mature cottonwood, shrub, and mature willow types in daytime (Tables 4 and 5). Gravel bar, grassland, and agriculture cover types were consistently used proportionately less than their availability. Willow-cottonwood thickets received greater than expected use during winter and fall at Glendive and during fall at Burns Creek. The young cottonwood type was selected for during summer at both study areas, and

Table 6. Comparison of diurnal habitat selection between radio-collared deer (RC) and survey flight observed deer (SF) at Burns Creek for winter, summer, and fall, 1985.

HABITAT TYPE	WINTER		SUMMER		FALL	
	RC	SF(58)	RC	SF(19)	RC	SF(59)
Gravel Bar	-	-	-	-	-	0
Willow Thicket	-	+	-	+	+	+
Yng. Cottonwood	-	+	+	-	+	0
Mat. Cottonwood	+	-	+	+	+	+
Shrub	+	+	+	-	+	-
Grassland	-	+	-	-	-	0
Mat. Willow	+	-	+	-	+	0
Green Ash	0	-	+	-	+	0
Agriculture	-	-	-	-	-	-

() number of habitat type points

+ utilization greater than availability

0 utilization equals availability

- utilization less than availability

Table 7. Comparison of diurnal habitat selection between radio-collared deer (RC) and survey flight observed deer (SF) at Glendive for winter, summer, and fall, 1985.

Habitat Type	WINTER		SUMMER		FALL	
	RC	SF(27)	RC	SF(14)	RC	SF(32)
Gravel Bar	-	-	-	+	-	-
Willow Thicket	+	+	-	+	+	+
Yng. Cottonwood	-	-	+	-	0	-
Mat. Cottonwood	NA	NA	+	0	+	0
Shrub	+	+	+	+	+	0
Fld. Grassland	NA	NA	-	-	-	-
Mat. Willow	+	-	+	-	+	-
Green Ash	0	-	+	-	+	-
Slough	NA	NA	+	-	0	+
Agriculture	-	-	-	-	-	-

() number of habitat type points
 + utilization greater than availability
 0 utilization equals availability
 - utilization less than availability
 NA ungrazed habitat not available

preferred during fall at Burns Creek. Green ash communities were selected for during summer and fall on both units.

At night, in addition to selecting for agriculture, radio-collared deer on the Glendive unit selected for green ash during winter, mature willow during summer, and young cottonwood, mature cottonwood, and shrub types during the fall (Table 5). Agricultural fields were exclusively selected for at Burns Creek during all seasons (Table 4).

Use and Selection of Agricultural Types

A total of 4,587 deer was observed on agricultural fields during spotlight surveys, including 3,054 at Elk Island, 1,218 at Burns Creek, and 315 at Glendive. Use of agricultural fields was generally greatest during winter and late summer/early fall (Fig. 8). At Glendive the greatest use of fields occurred during early summer, the time of least use at Burns Creek and Elk Island.

Alfalfa received the greatest amount of use among all agricultural types (Fig. 9) and was most preferred (Table 8). Alfalfa fields were used in proportion to their availability during winter and used less than expected during July at Glendive. Grain fields ranked second in deer use overall, with the majority occurring during winter and fall. Selection for irrigated grain was observed during November at Elk Island and Burns Creek. Sugar beet fields received their greatest use during fall and were

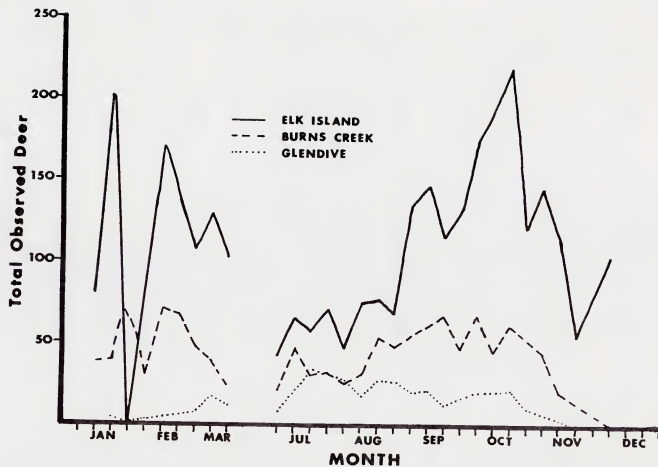


Figure 8. Number of deer observed during weekly spotlight counts for winter, summer, and fall, 1985, at Elk Island, Burns Creek, and Glendive study units.

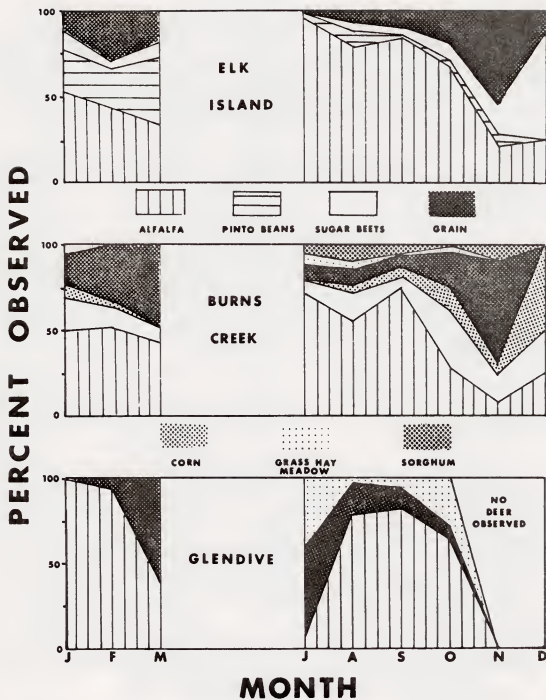


Figure 9. Percentage of deer observed during spotlighting in various agricultural crop types for Elk Island, Burns Creek, and Glendive study units during winter, summer, and fall months, 1985.

	JAN	FEB	MAR	JUL	AUG	SEP	OCT	NOV	DEC
1950									
1951									
1952									
1953									
1954									
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2009									
2010									
2011									
2012									
2013									
2014									

+	utilization greater than availability ($P < .05$)
0	utilization equals availability
-	utilization less than availability ($P < .05$)
NA	Not available
A	No deer were observed on agricultural fields

A No deer were observed on agricultural fields

selected for during December at Elk Island. Pinto bean fields received considerable use during the winter at Elk Island, but use did not exceed availability.

Corn and sorghum fields and grass hay meadows received the least deer use among crop types. Corn fields occurred on the Elk Island and Burns Creek units, but use reached that expected only at Burns Creek during fall. Use of corn fields during summer may have been underestimated by the difficulty in observing deer in standing corn; however radio-collared deer also made little use of this type. Although 50% of the deer observed at Burns Creek during December were seen in corn fields, only 4 deer were observed in the spotlight surveys. Sorghum was indicated to be selected for during September at Burns Creek, but this may have been an artifact of the location of 1 small field (10 ha) adjacent to cover. Grass hay meadows were preferred during July and October at Glendive, but use at other times and at Burns Creek was either less than or equal to that expected.

Agricultural fields receiving the greatest use by deer were generally located adjacent to cover. During winter the majority of use on agricultural fields occurred on those where residual crop material was available. In the case of alfalfa, greatest use occurred on fields not receiving a fall cutting.

Influences Of Hunting, Cattle, And Crop Harvest

During early fall, radio-collared deer exhibited no observable differences in movement or distribution, indicating that archery hunting and harvesting of corn and alfalfa/hay had little impact. During mid/late fall deer were more apt to move into larger tracts of riparian cover, or leave the river bottom and move into adjacent uplands. The use of islands also increased during this time. These changes coincided with the firearm hunting seasons, introduction of cattle onto the river bottom, and sugar beet harvest.

Radio-collared deer at the Burns Creek study unit were distributed primarily on islands during daylight in the fall. Of 8 deer with functional radios, 6 were usually located on islands, as compared with winter and summer when only 3 of 8 were associated with islands. Radioed deer associated with islands during the daytime commonly used agricultural fields on the floodplain during nocturnal periods.

Use of uplands by radio-collared deer at Burns Creek was recorded only in fall. Several deer, marked and unmarked were often observed moving onto islands and into uplands when pursued by hunters. One yearling female was repeatedly located off the floodplain in a hardwood draw 1 1/2 km from her summer range. This animal regularly moved onto agricultural fields on the floodplain at night.

Three other radioed deer were relocated occasionally off the floodplain.

A total of 22 marked deer were assumed to be present at Burns Creek prior to the hunting seasons in 1985. Of these, 10 (45%) were known to be harvested, including 5 of 9 radio-collared deer. Two of the 5 radioed deer were shot outside their normal summer range.

The introduction of cattle on the bottom did not appear to have the same general impact on deer distribution as hunting. Cattle were placed on the northern portion of the Burns Creek unit in mid November. A yearling female that had regularly used this area moved immediately to an adjacent area free of the cattle where she was harvested a week later. Patterns of distribution and habitat use at Glendive changed slightly only after cattle were introduced onto the bottom in mid November. Although radioed deer used areas restricted from cattle, no major shift in distribution was evident. Only limited hunting occurred on the Glendive unit, and none of the 7 marked deer were harvested.

The impact of sugar beet harvesting could not be fully evaluated because it occurred simultaneously with firearm hunting and cattle introductions. Harvesting of cash and forage crops occurs almost continuously from August through October. However, few aberrant movements of deer were noted until mid October.

Home Range

Home ranges as determined by convex polygon and AAR, of radio-collared deer varied among seasons, sexes, ages, and study units (Table 9). Due to the low numbers of radioed deer and variation among individuals, the only significant ($P < .05$) differences in AAR's were between summer and fall/winter and between total (24-hour) and daytime periods. There was a significant ($P < .025$, $r = .70$) relationship between AAR's and polygon home range size.

Adult female home ranges were generally smaller than other classes. Home ranges of adult females on the Glendive unit were larger than those at Burns Creek, while yearling females and fawns had smaller ranges at Glendive. Males usually had the largest home ranges followed by yearling females. Size of fawn ranges during the winter fell between adult females and yearling females.

All but one adult female had seasonal home ranges that overlapped. Summer home ranges were usually enclosed or largely overlapped by fall and winter ranges. Fall home ranges contained more outlying points, probably reflecting the influence of hunting pressure and cattle introductions onto the bottom. Winter range sizes probably reflect the influence of cattle and the nocturnal use of more distant agricultural fields.

Table 9. Winter, summer, and fall total (24 hour) and daylight convex polygon (PLY) and AAR home range sizes of radioed deer at Burns Creek and Glendive study units by season, age, and sex.

		BURNS CREEK					GLENDIVE				
Season											
Sex		PLY	(km ²)	AAR	(km)		PLY	(km ²)	AAR	(km)	
Age	N	x	SE	x	SE	N	x	SE	x	SE	
24 HOUR											
WINTER											
Fem.											
Ad.	1	.30	-	.48	-	2	.59	.02	.57	.05	
Yr.	1	2.70	-	1.04	-	1	.34	-	.41	-	
Fw.	3	1.15	.49	.62	.13	1	.69	-	.79	-	
Males	1	4.10	-	1.28	-	-	-	-	-	-	
SUMMER											
Fem.											
Ad.	4	.15	.02	.29	.03	6	.29	.12	.43	.08	
Yr.	3	.89	.62	.51	.22	-	-	-	-	-	
Males	1	.90	-	.76	-	-	-	-	-	-	
FALL											
Fem.											
Ad.	4	.69	.32	.45	.11	5	1.46	.19	.84	.16	
Yr.	3	1.58	.36	.73	.12	-	-	-	-	-	
Males	1	1.55	-	.60	-	-	-	-	-	-	
DAYLIGHT											
WINTER											
Fem.											
Ad.	1	.17	-	.34	-	-	-	-	-	-	
Yr.	1	.97	-	1.18	-	-	-	-	-	-	
Fw.	3	.72	.37	.59	.17	-	-	-	-	-	
Males	2	1.13	.48	1.56	.85	-	-	-	-	-	
SUMMER											
Fem.											
Ad.	4	.03	.01	.15	.07	6	.12	.04	.30	.07	
Yr.	3	.17	.07	.38	.19	-	-	-	-	-	
Males	1	.17	-	.33	-	-	-	-	-	-	
FALL											
Fem.											
Ad.	4	.68	.24	.50	.09	5	1.25	.23	.80	.13	
Yr.	3	1.05	.12	.70	.09	-	-	-	-	-	
Males	1	2.18	-	.72	-	1	.79	-	.97	-	

Influence of Cattle on Riparian Vegetation

The relative intensity and, to a lesser extent, the season of grazing influenced vegetational profiles and percentage canopy coverage of shrubs, grasses, and forbs in the mature cottonwood, green ash, and shrub communities (Fig. 10 and 11, and Tables 10 and 11). Overhead canopy cover did not differ significantly ($P > .05$) among grazing regimes for either the mature cottonwood (mean=81%, range 75-87%) or green ash (mean 91%, range 88-96%) communities.

Intensity

As grazing intensity increased, percentage canopy coverage of shrubs decreased in all 3 communities. Shrub coverage under light intensity grazing was significantly greater ($P < .05$) than under heavy grazing in all cases. Differences in shrub cover among other intensity combinations were variable. Among individual species, coverage of western snowberry (SYOC) consistently decreased as the intensity of grazing increased (Tables 12, 13, and 14). Coverage of Woods rose (ROWO) generally decreased as intensity increased, but apparently to a lesser degree than for snowberry. Poison ivy (Rhus radicans, RHRA) cover decreased under all grazing intensities in the mature cottonwood and shrub communities. Conversely, in the shrub community, the sagebrush species Artemisia cana (ARCA), Artemisia dracunculus (ARDR), and Artemisia ludoviciana

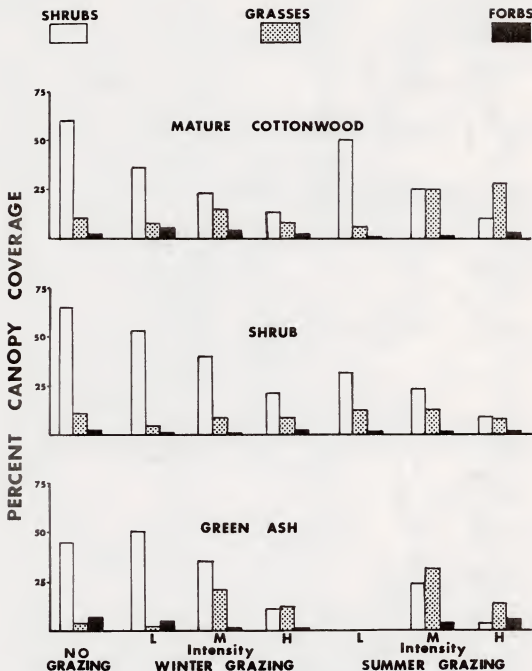


Figure 10. Percent canopy coverage of shrubs, grasses, and forbs under no grazing and light (L), moderate (M), and heavy (H) winter and summer grazing intensities for mature cottonwood, shrub, and green ash communities.



Figure 11. Vegetational profiles for mature cottonwood (MC), green ash (GA), and shrub (S) communities under nongrazed and light (L), moderate (M), and heavy (H) winter and summer grazed conditions.

Table 10. Percentage canopy coverage of shrubs, grasses, and forbs in the mature cottonwood, green ash, and shrub communities under nongrazed and light, moderate, and heavy winter and summer grazing.

COMMUNITY TYPE, VEGETATION CLASS AND GRAZING SEASON AND INTENSITY		% CANOPY COVERAGE	SIGNIFICANCE LEVEL
MATURE COTTONWOOD			
<u>Shrubs</u>			
non grazed	61.82	a	<u>P</u> <.0001
summer light	51.07		
winter light	37.83		
summer moderate	25.58		
winter moderate	23.17		
winter heavy	13.67		
summer heavy	10.08		
<u>Grasses</u>			
summer heavy	29.00		<u>P</u> <.0001
summer moderate	25.17		
winter moderate	17.58		
nongrazed	11.17		
winter heavy	8.67		
winter light	7.83		
summer light	6.58		
<u>Forbs</u>			
winter light	6.25		<u>P</u> >.05
winter moderate	3.67		
winter heavy	2.92		
summer heavy	2.42		
nongrazed	2.25		
summer moderate	1.25		
summer light	.25		
GREEN ASH			
<u>Shrubs</u>			
nongrazed	55.58		<u>P</u> <.0001
winter light	50.25		
winter moderate	37.42		
summer moderate	23.58		
winter heavy	11.33		
summer heavy	3.47		

^a lines indicate no significant difference (P>.05) among means

Table 10. - Continued

<u>Grasses</u>		
summer moderate	32.08	P<.0001
winter moderate	21.42	
summer heavy	14.58	
winter heavy	12.17	
nongrazed	4.42	
winter light	2.08	

<u>Forbs</u>		
nongrazed	6.50	P<.0001
summer heavy	6.08	
winter moderate	5.08	
summer moderate	4.27	
winter heavy	1.33	
winter light	1.25	

SHRUB

<u>Shrubs</u>		
nongrazed	67.00	P<.0001
winter light	53.50	
winter moderate	35.33	
summer light	30.83	
summer moderate	23.17	
winter heavy	21.08	
summer heavy	9.17	

<u>Grasses</u>		
summer moderate	12.42	P<.005
summer light	12.17	
nongrazed	11.50	
summer heavy	8.50	
winter heavy	7.41	
winter moderate	7.41	
winter light	4.83	

<u>Forbs</u>		
nongrazed	2.42	P<.04
winter heavy	1.98	
summer light	1.83	
summer heavy	1.17	
winter light	1.08	
summer moderate	.58	
winter moderate	.58	

Table 11. Variation in vegetation density associated with grazing season and intensity in mature cottonwood, green ash, and shrub communities.

Community and Grazing Season and Intensity	Height Class (m)	Mean Density	Significance Level
<u>Mature Cottonwood</u>			
	0.0-0.5		
nongrazed		5.00	a P<.0001
summer light		4.73	
winter light		4.67	
winter moderate		4.13	
summer moderate		3.53	
winter heavy		3.40	
summer heavy		2.13	
	0.5-1.0		
nongrazed		2.80	P<.0001
winter light		2.80	
summer light		1.86	
winter moderate		1.73	
summer moderate		1.67	
winter heavy		1.27	
summer heavy		1.13	
	1.0-1.5 ^b		
	1.5-2.0 ^c		
<u>Green Ash</u>			
	0.0-0.5		
winter light		4.53	P<.0001
summer moderate		4.13	
winter moderate		4.00	
nongrazed		3.73	
winter heavy		1.80	
summer heavy		1.40	
	0.5-1.0		
nongrazed		2.07	P<.03
winter light		1.53	
winter moderate		1.40	
summer moderate		1.27	
winter heavy		1.07	
summer heavy		1.07	

a lines indicate no significant difference ($P > .05$) among means

b no significant difference ($P < .05$) among groups, mean density range 1.0-1.07

c no significant difference ($P < .05$) among groups, mean density equalled 1.0 for all samples

Table 11. - Continued

	1.0-1.5		
nongrazed	2.07		$\underline{P} < .007$
winter heavy	1.40		
winter light	1.20		
summer heavy	1.13		
winter moderate	1.07		
summer moderate	1.00		
	1.5-2.0		
nongrazed	2.53		$\underline{P} < .0001$
winter heavy	1.93		
winter light	1.07		
winter moderate	1.07		
summer moderate	1.07		
summer heavy	1.07		
<u>Shrub</u>	0.0-0.5		
nongrazed	5.00		$\underline{P} < .0001$
winter light	4.54		
summer light	4.33		
winter moderate	4.13		
summer moderate	3.87		
winter heavy	3.60		
summer heavy	1.80		
	0.5-1.0		
nongrazed	2.73		$\underline{P} < .0001$
winter light	2.27		
summer light	1.67		
winter moderate	1.40		
summer moderate	1.20		
winter heavy	1.07		
summer heavy	1.00		
	1.0-1.5 ^b		
	1.5-2.0 ^c		

Table 12. Plant species composition and percent canopy coverage in the mature cottonwood community under no grazing and light (L), moderate (M), and heavy (H) winter and summer grazing.

SPECIES	NO GRAZING			WINTER GRAZING			SUMMER GRAZING		
				INTENSITY			INTENSITY		
	L	M	H	L	M	H	L	M	H
<u>SHRUBS & VINES</u>									
ARCA*									
CLLI	1.00	1.17	3.67	.08			+	1.00	1.08
COST	.17						.50	.08	+
PAQU	.53	.92	1.75	.08					
RHRA	13.42	.58	1.92				1.00	.33	.08
RISE	2.00						2.00	.17	
ROWO	11.00	4.92	1.92	11.25			31.67	14.00	7.83
SHAR	.08		1.25						
SYOC	32.25	30.25	13.25	2.25			15.92	10.08	1.08
VIRI	+								
<u>GRASSES & SEDGES</u>									
AGRE	.42	.08							
AGTR	.25	.25	1.25	6.83			1.17	.75	.60
BRIN	9.60	.17	.92						
BRJA							.08	1.92	.75
CALO		+							
CASP			.08						
ELCA	.33	.92	8.42	+			.42	+	+
MURA	.08		2.00						
PHAR		+					.50	.92	.08
POSP	.83	.17	1.17	.33					
UNID		6.25	1.50	1.17			4.42	21.67	27.50
<u>FORBS</u>									
AMPS			1.25				.08		
EUES		5.17		.75					
GLLE			1.00						
MEOF	1.00	.25	1.17	1.83			.08	.83	.42
RACO				+					
SOGI		.58	+						
TAOF				.17					
THAR									.08
UNID	1.08	.33	.08	.08			.08	.67	1.92

+ present in community but not sampled

* see Appendix A, Table 15 for scientific and common names

Table 13. Plant species composition and percent canopy coverage in the green ash community under no grazing and light (L), moderate (M), and heavy (H) winter and summer grazing.

SPECIE	NO GRAZING		WINTER GRAZING			SUMMER GRAZING	
			INTENSITY			INTENSITY	
			L	M	H	M	H
<u>SHRUBS & VINES</u>							
CLLI*						+	+
PAQU	.17					.08	+
RHRA	.17					.17	
RISE	1.42	.42				2.08	.08
ROWO	5.17	.67			.25	4.33	2.58
SASP	.08			.08	.08		
SYOC	38.17	49.17	36.50	11.00		17.42	.92
<u>GRASSES</u>							
AGRE	1.00	.18			7.08		
AGTR	+	.08	.50		1.08	+	
BRIN	+						
BRJA				7.25			
MURA		.17		1.08			
POSP	+		11.25		3.83	.25	.08
UNID	3.42	1.58	1.33	.17		31.83	14.42
<u>FORBS</u>							
ACMI				.58			+
ARLA	.08						
CIAR	.08						
COSE	.25	.67	.08			.08	
MEOF	.42	.08	+		.50	1.58	2.50
PHHE						.17	
PLMA					+	.08	
SILO	.08		+				
VICA	.08						
UNID	5.50	4.42	.58	.83		2.50	3.58

+ present in community but not sampled

* see Appendix A, Table 15 for scientific and common names

Table 14. Plant species composition and percent canopy coverage in the shrub community under no grazing and light (L), moderate (M), and heavy (H) winter and summer grazing.

SPECIE	NO	WINTER GRAZING			SUMMER GRAZING		
	GRAZING	INTENSITY			INTENSITY		
		L	M	H	L	M	H
<u>SHRUBS & VINES</u>							
AMAL*	.17						
ARCA		+	3.42	.50	+	.08	
ARDR			.25			.08	.08
ARLU		+	2.17	1.33			
CLLI					+	.67	
PAQU					.50		
RHRA	6.50				.08	.08	
RISE						.08	
ROWO	18.67	3.08	.08	18.92	22.50	14.42	8.67
SHAR	+						
SYOC	39.50	50.42	37.98	.75	7.25	4.42	
UNID VINE	.50						
<u>GRASSES</u>							
AGCR		+		.42			
AGTR	1.00	.67	.08	.50	.08	.58	
BRIN	.75						
BRJA	.08			6.25	9.67	3.17	3.25
CALO	.17		3.50				
ELCA	+		2.25			.17	
MURA			1.50			.08	
POSP	7.33	.58		.33	.33	.67	
UNID	1.67	3.50	.17		2.08	7.83	5.25
<u>FORBS</u>							
ACMI	+						
AMPS			.50				
CHAL	.08						
CIAR				.67			
GRSQ				.67			
MEOF	2.00						
SILO				.08			
SOGI				+			
TAOF	.08		+				
THAR		.17			.17		
THRH	.17	.08					
TRDU	+			.42			
UNID	.08	.83	.08	.17	1.67	.58	1.17

+ present in community but not sampled

* see Appendix A, Table 15 for scientific and common names

(ARLU) occurred only in grazed stands. Coverage of other shrubs was highly variable within and among communities, precluding any detectable trends associated with intensity of grazing.

Percentage canopy coverage of grasses and forbs was variable. Overall, grass cover was generally greater under stands grazed moderately, while no apparent pattern was observed for forb coverage (Fig. 10 and Table 10). Similarly, percent coverage of individual grasses and forbs was highly variable among community types and stands, masking any apparent changes or patterns possibly associated with grazing intensity (Tables 12, 13, and 14).

Mean density scores for vegetational profiles decreased as grazing intensity increased in the mature cottonwood and shrub communities, with the greatest difference observed for height classes less than 1.5 m (Table 11). Scores in green ash stands decreased as intensity of grazing increased at the 0.5-1.0 m height class, while being variable in other classes. Significant ($P < .05$) differences due to grazing intensity were variable and did not follow any evident patterns.

Season

Summer grazing appeared to influence canopy coverage of shrubs and grasses to a greater extent than winter grazing. Summer-grazed areas generally had less total shrub and greater total grass cover than comparable winter-

grazed areas (Fig. 10 and Table 10). However, differences associated with season were significant ($P < .05$) only within the shrub community. Among individual shrub species, the percent coverage of snowberry was greater under winter grazing in all communities, while coverage of Woods rose was similarly greater under summer-grazed conditions (Tables 12, 13, and 14). Among grasses, the coverage of Japanese brome (Bromus japonicus, BRJA) was generally greater under summer grazed conditions, while smooth brome (Bromus inermis, BRIN) generally had greater coverage under winter grazing.

Percent canopy coverage of forbs was highly variable and no discernable patterns or differences due to season of grazing were apparent.

Mean density scores were generally lower under summer grazed conditions for all height classes in vegetational profiles in the mature cottonwood and green ash community types, and for the 0.0-0.5 m class in profiles for the shrub type. However, the only significant ($P < .05$) difference in profile density associated with season of grazing was under heavy grazing in the shrub type at the 0.0-0.5 m height class.

DISCUSSION AND CONCLUSIONS

The results of this study confirm the general importance of bottomland habitats associated with rivers and streams to white-tailed deer in the Great Plains (Cook 1945, Allen 1968, Severson and Boldt 1978, Zwank et al. 1979, Smith and Flake 1983, Swenson et al. 1983, and Herriges 1986). On the lower Yellowstone River, deer were distributed primarily along bottomlands and made only little use of adjacent uplands. Herriges (1986) also reported little use of uplands.

Staines (1974, in Harmoning 1976) states that "deer do not necessarily occupy areas with the best of any one particular factor, but are generally found where there is the best combination of all the major ones." It should follow that the occurrence and abundance of whitetails in riparian habitats in prairie regions could likewise be related to the influence of several factors. Indeed, my findings corroborate those of Herriges (1986), who indicated that distribution and habitat use of white-tailed deer on the lower Yellowstone were influenced by the kinds, amounts, and distribution of vegetation, topography and physiography, weather and climate, and land use and operational practices within the river valley as well as by behavioral and social factors relating to the sex and age of the deer.

The amount of woody riparian vegetation appeared to be the single most important, if not the ultimate factor influencing the relative abundance of white-tailed deer within the lower Yellowstone River ecosystem. Nearly three-fourths (70%) of the variability observed in density distribution of deer was explained by riparian cover alone. Similarly, habitat use analyses generally, as well as within intensive study units, indicated significant preference for riparian cover as compared to more open types. Numerous other investigators have also found the importance of woody vegetation to white-tailed deer (Montgomery 1963, Allen 1968, Martinka 1968, Sparrowe and Springer 1970, Kohn and Mooty 1971, Suring and Vohs 1979, Herriges 1986).

Riparian cover provides both thermal and security cover and forage which are of critical importance for the survival of white-tailed deer. Moen (1968) and Ozoga and Gysel (1972) discussed the significance of cover to the energetics of white-tailed deer during winter weather. Availability of security cover may allow deer to inhabit areas of human disturbance (Herriges 1986). Native browse associated with riparian cover made up 58.5% and 37.5% by volume of yearlong diets of white-tailed deer for the Missouri and Yellowstone Rivers, respectively (Allen 1968, Dusek 1984).

Herriges (1986) indicated that the daytime preference of deer for mature cottonwood, shrub, green ash, and mature willow cover types was related to the greater relative abundance of shrubs within these types. Results from this study indicate those daytime preferences may apply generally along the lower Yellowstone River. The significant preference of willow-cottonwood thickets during fall at Burns Creek probably reflected use of islands, which are generally dominated by younger seral stages. The preference for willow-cottonwood thickets at Glendive was assumed to be influenced by the presence of cattle and limited availability. These factors may have also influenced selection for the young cottonwood type during summer and fall at Burns Creek.

Cattle and hunting were secondary factors affecting deer distribution. General avoidance of cattle or greater use of nongrazed as compared with grazed areas has been previously reported for white-tailed deer (Ellisor 1969, Sparrowe and Springer 1970, Kramer 1973, Suring and Vohs 1979, Crouch 1981, Gavin et al. 1984). Such avoidance may reflect either alteration of food and cover (Mackie 1978) or a social intolerance (Lonner 1975). My findings suggest the latter was of greater importance. General observations and relocations of radioed deer indicated an immediate exodus of deer after cattle were introduced. When cattle were removed deer promptly reestablished themselves in

grazed areas. Similar results have been reported for white-tailed deer along the lower Yellowstone (Herriges 1986) and for Columbian white-tailed deer (Gavin et al. 1984).

Vegetation analyses showed that grazing reduced shrub and increased grass cover within important riparian cover types. Taylor (1986) also associated a reduction in shrub cover with cattle grazing in riparian habitats. These changes could reduce forage supplies for deer. Snowberry, the principal decreaser, is a significant item in the diet of whitetails in bottomland habitats (Allen 1968, Herriges 1986). Over the long term, grazing could also increase the rate of succession from mature cottonwood and shrub communities to grassland which is the climatic climax type on the study area (Boggs 1984). My results and those of Herriges (1986) indicate very little use of grasslands by white-tailed deer. Accordingly, the potential to support deer may be decreased.

Hunting affected the distribution of deer primarily through temporary displacement. Movement to uplands and islands may reflect selection for areas of lower disturbance levels. Hood and Inglis (1974) reported that deer subjected to intense disturbance during cattle roundups moved to areas of minimal disturbance. Although Sparrowe and Springer (1970) found that activities associated with archery hunting influenced the distribution

of deer, this did not appear to be the case along the lower Yellowstone River where hunter densities may have been relatively lower.

The combination of cattle introduction and hunting activities resulted in increased movements by deer as evidenced by larger home ranges during fall. Increased movement can increase the vulnerability of deer to hunting and other mortality factors (Larson et al. 1978). This could explain the relatively high harvest rate of marked deer at Burns Creek. Forty five percent, including 3 of 6 adults, were harvested. Overall harvest rate of deer on the study area during 1985 was 34% (Dusek pers. comm.).

The results of this study confirm previous conclusions of Dusek (1984) and Herriges (1986) that agriculture plays an important role in the ecology of white-tailed deer along the lower Yellowstone River. Other studies (Severson and Boldt 1978, Swenson et al. 1983) have also shown that the combination of agriculture and riparian habitats provide an important ecosystem for whitetails in prairie regions. The immediate presence and use of agriculture may provide for a complex capable of supporting greater densities of deer than might otherwise occur (Dusek 1984).

Season, distribution and availability of crop types, cropping practices, and livestock were factors influencing the use and selection of agricultural fields, as reported by Murphy et al. (1985), Compton (1986), and Herriges

(1986). Forage conditions within natural riparian communities may also play a role (Herriges 1986).

Seasonal use of fields followed patterns observed by others (Progulske and Duerre 1964, McCullough 1982, and Herriges 1986). Increased use through summer is assumed primarily attributable to greater movement and use of fields by does with fawns (Herriges 1986). The relatively high use of fields during fall and winter agrees with reported food habits of deer on the area; agricultural crops comprise 51% of the diet between October and April (Dusek 1984).

Fields adjacent to cover generally received the greatest use, especially during summer and early fall. Alfalfa fields received the majority of use during the growing season. During fall, use shifted from alfalfa to fields from which row crops (sugar beets, pinto beans, grain, and corn) were harvested. Fields with any residual crop material were selected for during winter. The presence of cattle on fields invariably limited their use by deer.

MANAGEMENT IMPLICATIONS

1. The significant relationship between deer density distribution and amount of riparian cover provides further evidence of the importance of riparian tree and shrub communities to sustaining deer populations along the lower Yellowstone and probably other river systems in the Northern Great Plains. In general, the greater the amount of riparian cover (forest and shrub) that is provided or maintained, the greater the numbers and density of whitetails that will be sustained. Mid-to-late seral stages such as mature cottonwood, shrub, mature willow, and green ash types are particularly important. Unrestricted river flows, stream dynamics, and successional relationships of the native vegetation are currently continuously developing and maintaining these types. Any significant alteration of river flowage and dynamics could alter successional relations and ultimately the ecology of white-tailed deer. Similarly, other land use or management practices, such as land clearing for field development or logging of riparian timber, that lead to a reduction in tree and shrub cover along the floodplain could reduce deer numbers at least locally.

The close linear relationship between deer density and amount of riparian cover could also provide a useful tool for determining relative concentrations of deer within and between portions of river bottom. However, further testing in other riverine habitats, and over a wider range of deer densities than occurred on the lower Yellowstone study area, should be undertaken before the model is applied elsewhere.

2. The significant negative relationship between the presence of cattle and white-tailed deer use of bottoms would imply that livestock grazing on wildlife management areas and other public lands in riparian areas of eastern Montana should be approached with caution. Grazing on such areas could result in increased deer use of neighboring private lands and greater depredation than might otherwise occur. Although, winter would seem to be the most suitable period to graze cattle along the bottom on the basis of relative impacts to native vegetation, this would also coincide with the heaviest use by deer of riparian forest and shrub communities, including both floodplain and large islands (Herriges 1986). Summer grazing could be the least favorable in that pregnant does spatially segregate themselves (Hawkins and Klimstra 1970) during this period and space may be at a premium.

3. My findings concur with Herriges (1986) that the development of agricultural crops, particularly

alfalfa, on state-owned or managed lands adjacent to riparian cover could benefit deer and reduce the use of privately cultivated crops. These developments should include provisions for residual crop material to remain available following the growing season and any harvest that may occur.

4. Spotlight counts along the lower Yellowstone River can be used to evaluate crop type selection and use and should be further analyzed as a tool for population estimation and trends (McCullough 1982). Late summer and early fall would be the best time to conduct counts (Herriges 1986). Spotlighting does not appear practical for sex and age classification along the river bottom because of high numbers and flighty behavior of deer in fields.

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APPENDICES

Appendix A - Tables

Table 15. Acronym, scientific name¹, and common name² of plant species listed in Tables 12-14.

SHRUBS & VINES

AMAL	<u>Amelanchier alnifolia</u>	Saskatoon serviceberry
ARCA	<u>Artemisia cana</u>	silver sagebrush
ARDR	<u>Artemisia dracunculus</u>	tarragon sagewort
ARLU	<u>Artemisia ludoviciana</u>	Louisiana sagewort
CLLI	<u>Clematis linguistifolia</u>	western white clematis
COST	<u>Cornus stolonifera</u>	red-osier dogwood
PAQU	<u>Parthenocissus quinquefolia</u>	Virginia creeper
RHRA	<u>Rhus radicans</u>	poison ivy
RISE	<u>Ribes setosum</u>	redshoot gooseberry
ROWO	<u>Rosa woodsii</u>	Woods rose
SASP	<u>Salix species</u>	willow
SHAR	<u>Shepherdia argentea</u>	silver buffaloberry
SYOC	<u>Symphoricarpos occidentalis</u>	western snowberry
VIRI	<u>Vitis riparia</u>	riverbank grape
UNID		unidentified

FORBS

ACMI	<u>Achillea millefolium</u>	common yarrow
AMPS	<u>Ambrosia psilostachya</u>	western ragweed
ARLA	<u>Arctium lappa</u>	great burdock
CHAL	<u>Chenopodium album</u>	lambsquarters goosefoot
CIAR	<u>Cirsium arvense</u>	Canada thistle
COSE	<u>Convolvulus sepium</u>	bindweed
EUES	<u>Euphorbia esula</u>	leafy spurge
GLLE	<u>Glycyrrhiza lepidota</u>	American licorice
GRSQ	<u>Grindelia squarrosa</u>	curlycup gumweed
MEOF	<u>Melilotus officinalis</u>	yellow sweetclover
PHHE	<u>Physalis heterophylla</u>	clammy groundcherry
PLMA	<u>Plantago major</u>	common plantain
RACO	<u>Ratibida columnifera</u>	prairie coneflower
SILO	<u>Sisymbrium loeselii</u>	smallpod tumbled mustard
SOGI	<u>Solidago gigantea</u>	goldenrod
TAOF	<u>Taraxicum officinale</u>	common dandelion
THAR	<u>Thlaspi arvense</u>	field pennycress
THRH	<u>Thermopsis rhombifolia</u>	prairie thermopsis
TRDU	<u>Tragopogon dubius</u>	yellow salsify
VICA	<u>Viola canadensis</u>	Canada violet
UNID		unidentified

¹ Scientific names follow Booth (1972) and Booth and Wright (1966).

² Common names follow Scott and Wasser (1980) or, for species not listed by Scott, Booth (1972) and Booth and Wright (1966).

Table 15. - Continued

GRASSES & SEDGES

AGCR	<u>Agropyron cristatum</u>	crested wheatgrass
AGRE	<u>Agropyron repens</u>	quackgrass
AGTR	<u>Agropyron trachycaulum</u>	slender wheatgrass
BRIN	<u>Bromus inermis</u>	smooth brome
BRJA	<u>Bromus japonicus</u>	Japanese brome
CALO	<u>Calamovilfa longifolia</u>	prairie sandreed
CASP	<u>Carex species</u>	sedge
ELCA	<u>Elymus canadensis</u>	Canada wildrye
MURA	<u>Muhlenbergia racemosa</u>	marsh muhly
PHAR	<u>Phalaris arundinacea</u>	reed canary grass
POSP	<u>Poa species</u>	bluegrass
UNID		unidentified

Appendix B - Figures

LOWER YELLOWSTONE RIVER

Montana Department of Fish, Wildlife and Parks

Dear _____,

Because you are a landowner on the lower Yellowstone River bottom where research on white-tailed deer is being conducted, the following questions answered by yourself will be of significant value to the study. This study is aimed toward evaluating white-tailed deer habitat use and population trends as they relate to agriculture, livestock, and other land use practices. A more complete understanding of the relationship between white-tailed deer and land use practices will enable the Montana Department of Fish, Wildlife, and Parks to better manage the deer with regard to landowners and their operations. Your cooperation will benefit you and the department.

Would you please rank (numbers 1 through 6), in descending order of importance, the following land use practices with respect to your operation on or adjacent to the Yellowstone River floodplain.

- _____ Livestock
- _____ Irrigated Alfalfa/Hay
- _____ Irrigated Cash Crops (small grains, corn, beets, etc.)
- _____ Dryland Alfalfa/Hay
- _____ Dryland Cash Crops (small grains, corn, beets, etc.)
- _____ Other (Please specify _____)

If livestock is of major importance to your operation, would you please list what season you graze riparian forest. _____

Do you feel that your type of operation leads to depredation problems by white-tailed deer? _____

Other comments concerning this questionnaire or the white-tailed deer population on your property with respect to land use practice.

Note: The individual responses to this survey will be held confidential; only a summary of the total survey results will be reported.

Figure 12. Landowner questionnaire.